



THE UNIVERSITY *of* EDINBURGH

Edinburgh Research Explorer

Age vectors vs. axes of intraspeaker variation for vowel formants in North American and Scottish English

Citation for published version:

Thomas, E, Mielke, J, Fruehwald, J, Holley, J, McAulliffe, M, Sonderegger, M, Stuart-Smith, J, Dodsworth, R & Kendall, T 2018, 'Age vectors vs. axes of intraspeaker variation for vowel formants in North American and Scottish English', LabPhon 16, Lisbon, Portugal, 19/06/18 - 22/06/18.

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Publisher's PDF, also known as Version of record

General rights

Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.



Age vectors vs. axes of intraspeaker variation for vowel formants in North American and Scottish English

Erik R. Thomas*, Jeff Mielke*, Josef Fruehwald†, Jordan Holley*, Michael McAuliffe‡, Morgan Sonderegger†, Jane Stuart-Smith§, Robin Dodsworth*, and Tyler Kendall¶

* North Carolina State University, † University of Edinburgh, ‡ McGill University, § University of Glasgow, ¶ University of Oregon

SPADE
Speech Across Dialects of English



Introduction

We examine vowel formant variation in several natural speech corpora of North American and United Kingdom English. Labov (1994) has suggested that a speaker's tokens of a particular vowel will be aligned along an axis coinciding with the direction that vowel is shifting diachronically in a given community. We compare the direction of change in apparent time with the axis of intraspeaker variation, for several vowel phonemes, in order to test this assertion. This is an opportunity to use Polyglot (McAuliffe et al. 2017, Figure 1) for large-scale vowel analysis. This is phase one of a project which will measure dozens of English corpora from both sides of the Atlantic.

Data

We measured 547,344 stressed vowels from six speech corpora:

- **Santa Barbara corpus** subsets (Western U.S. and Northern Cities, Du Bois et al. 2000)
- **Raleigh corpus** (Raleigh, North Carolina, U.S. urban South, Dodsworth and Kohn 2012)
- **Buckeye corpus** (Columbus, Ohio, U.S. North Midland, Pitt et al. 2007)
- **International Corpus of English, Canadian subset (ICE-CAN)** (Canada, Greenbaum and Nelson 1996)
- **Sounds of the City corpus** (Glasgow, Scotland, Stuart-Smith 2014)
- **Scottish Corpus of Texts and Speech (SCOTS)** (Scotland, Anderson et al. 2007)

The analysis is limited to words that are not known to have been involved in context-sensitive change in any of the dialects under study, determined using UNISYN (Fitt 2000).

Methods

- Polyglot was used to measure F1 and F2 at the nucleus (1/3 time point) of each vowel.
- Optimal formant measurements for each token were selected in a FAVE-like (Rosenfelder et al. 2011) manner using prototypes for each category. The first pass was based on corrected and pruned measurements of the same corpora, and then prototypes were re-estimated for each speaker's data five times.
- Selected formant measurements were normalized using the Lobanov method (Lobanov 1971). Speaker medians for various vowel categories are shown in Figure 2.
- **Age vectors** (thick arrows in Figure 3) were calculated using the mean normalized F1 and F2 measurements for the oldest and youngest generation within each corpus (young vs. old for Buckeye, birth year before 1950 vs. after 1967 for Raleigh and SCOTS, older and 1980s middle-aged vs. 1980s-2000s young for Sounds of the City, birth year before vs. after 1950 for ICE-CAN, and age at recording over vs. under 35 for Santa Barbara).
- **Axes of intraspeaker variation** (dotted line segments in Figure 3) were found by performing a principal component analysis for F1 and F2 of each speaker-vowel combination with at least 20 tokens. The loadings were used to calculate the angle of the main axis of variation for each speaker-vowel combination. These were averaged across speakers within each regionally-defined group. The length of each line segment represents the mean standard deviation of vowel variation along the axis.

Acknowledgments

The U.S. portion of this project is supported by NSF grant SMA-1730479, the Canadian portion of this project is supported by SSHRC and NSERC, and the U.K. portion of this project is supported by AHRC and ESRC. The map is courtesy of the National Library of Scotland. Thanks also to Arlie Coles and Rachel Macdonald.

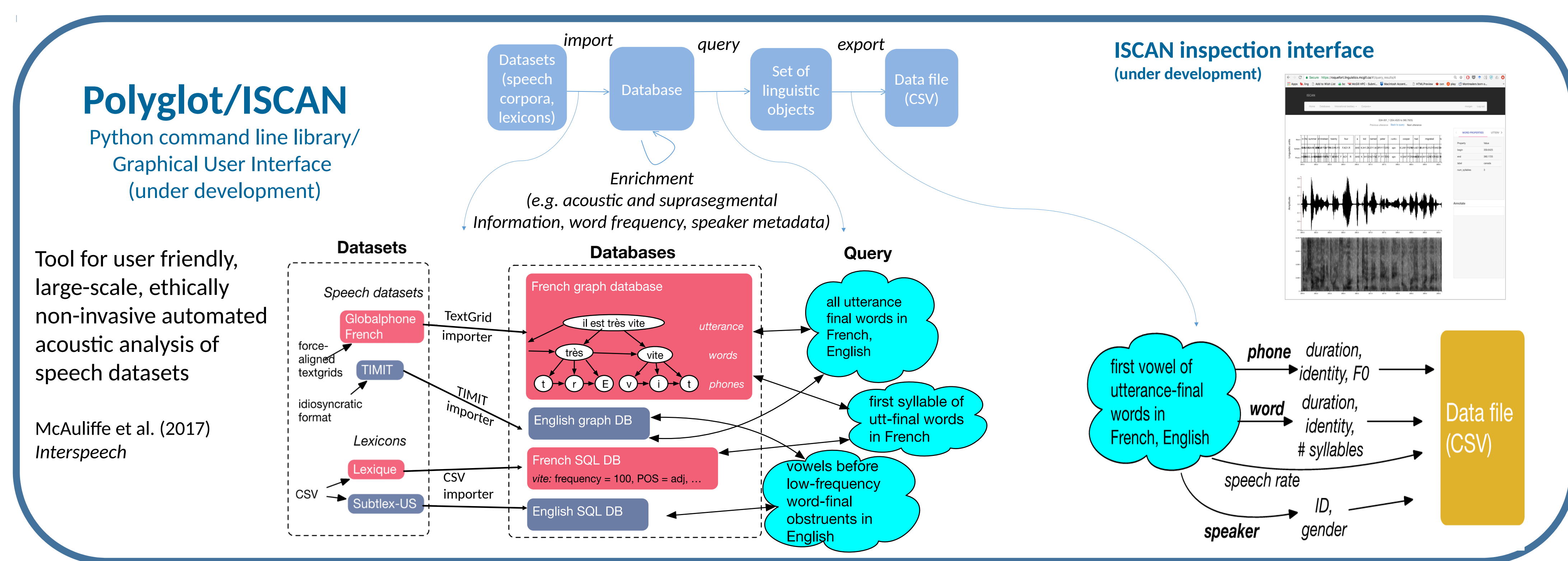


Figure 1: The Polyglot/ISCAN system for acoustic analysis of speech datasets

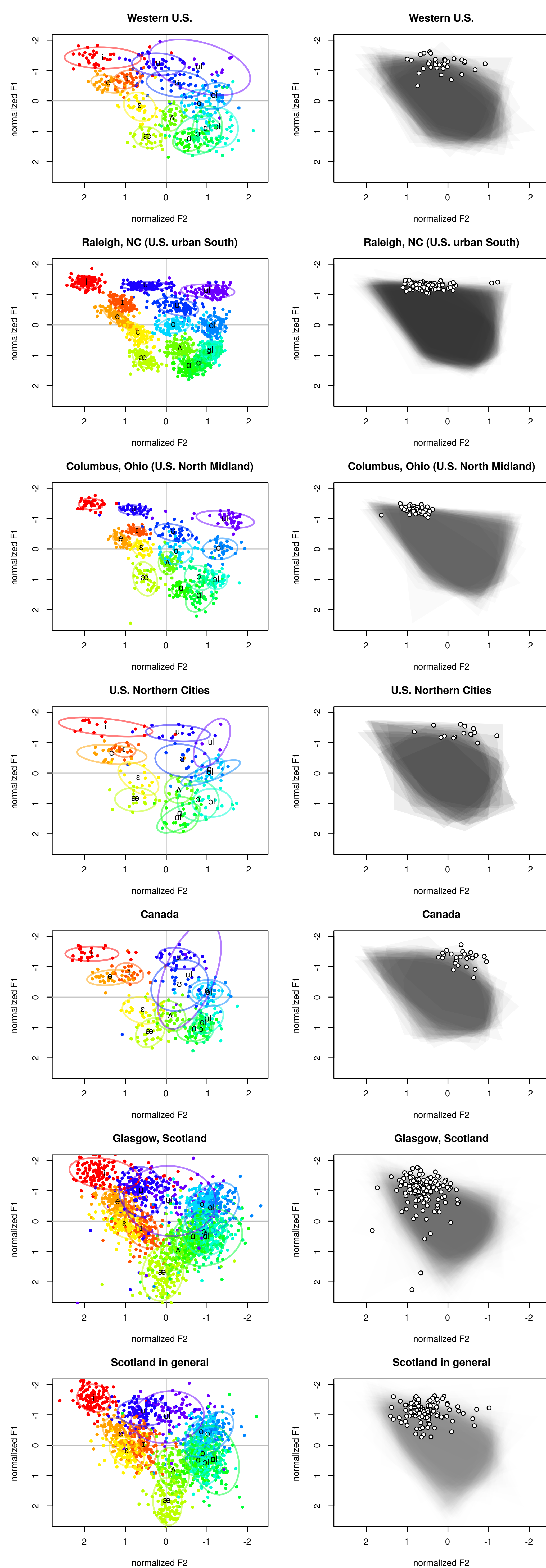


Figure 2: Left: speaker medians for selected vowel categories grouped by dialect/corpus; Right: convex hulls for each speaker's vowel spaces, with speaker median GOOSE vowels (/u/) highlighted

Age vectors and axes of variation

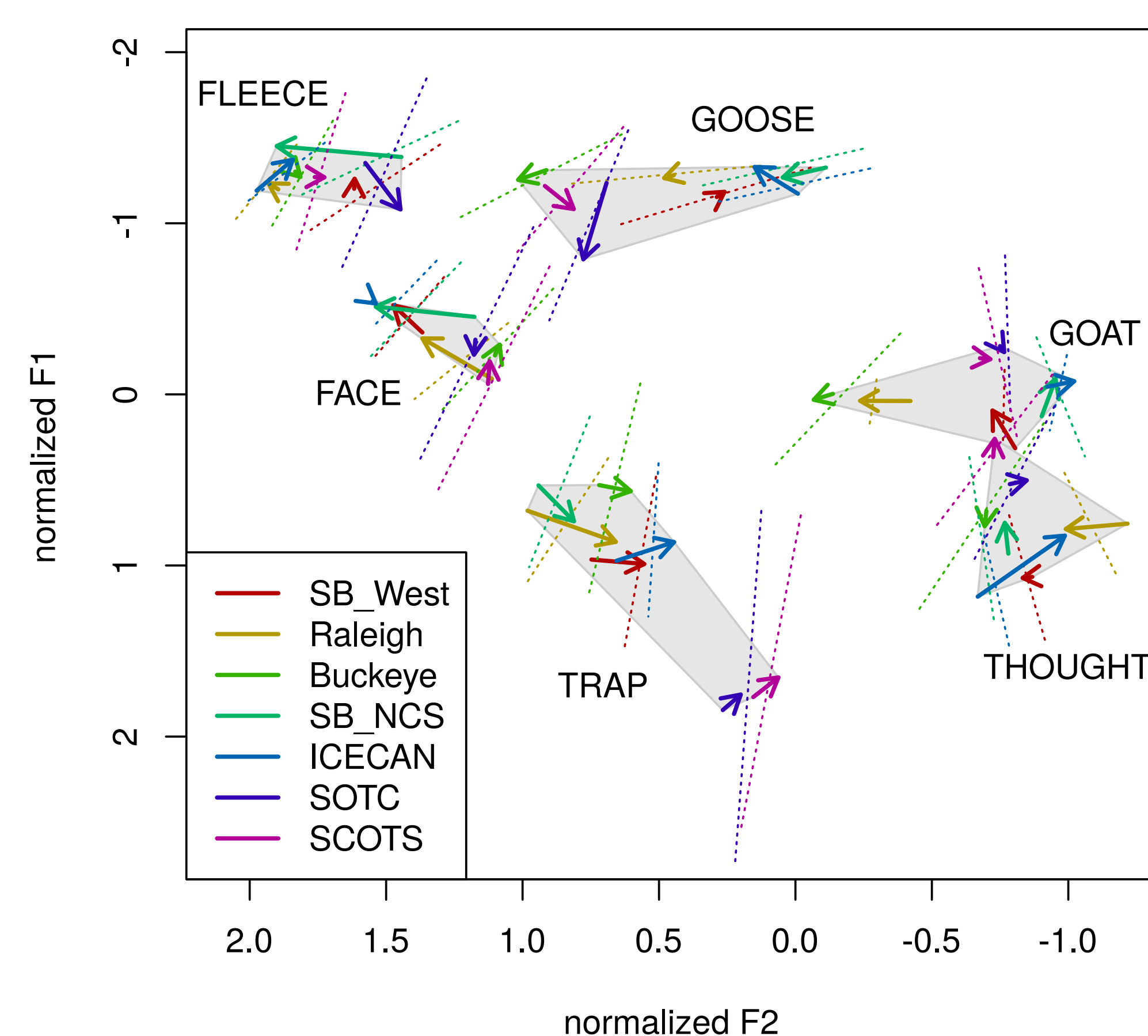


Figure 3: Age vectors (reflecting change in apparent time; arrows) and axes of intra-speaker variation (dotted lines) for six vowels across seven groups of speakers from six corpora.

Conclusions

- In the majority of cases, there is no obvious connection between age vectors and axes of intra-speaker variation, as Figure 3 shows.
- For most vowels, the axis of intraspeaker variation was aligned vertically, presumably corresponding to the degree of jaw opening for individual tokens.
- The GOOSE vowel in North American English is an important exception: the axis of intraspeaker variation is aligned horizontally, which also happens to be the axis of diachronic change for this vowel across North America.
- The horizontal alignment differentiated GOOSE from the less flat orientation of the other high, tense vowel (FLEECE); from the vertical orientations of other rounded vowels such as THOUGHT and GOAT; and even from the vertical orientations observed for GOOSE in the two Scottish corpora.
- This anomalous GOOSE pattern calls for an explanation, but it may help to explain why fronting and unrounding of high back vowels are common shifts across languages.

Bibliography

- Anderson, J., D. Beavan, and C. Kay. 2007. SCOTS: Scottish corpus of texts and speech. In *Creating and digitizing language corpora*, 17–34. Palgrave Macmillan UK.
- Dodsworth, Robin, and Mary Kohn. 2012. Urban rejection of the vernacular: The SVS undone. *Language Variation and Change* 24:221–245.
- Du Bois, J. W., W. L. Chafe, C. Meyer, S. A. Thompson, and N. Martey. 2000. Santa Barbara Corpus of Spoken American English. *Linguistic Data Consortium* CD-ROM.
- Fitt, Susan. 2000. Documentation and user guide to unisyn lexicon and post-lexical rules. URL <http://www.cstr.ed.ac.uk/projects/unisyn/>, technical Report, Centre for Speech Technology Research, University of Edinburgh.
- Greenbaum, S., and G. Nelson. 1996. The international corpus of English (ICE) project. *World Englishes* 15:3–15.
- Labov, William. 1994. *Principles of linguistic change: Internal factors*. Oxford: Blackwell.
- Lobanov, Boris M. 1971. Classification of russian vowels spoken by different speakers. *Journal of the Acoustical Society of America* 49:606–608.
- McAuliffe, M., E. Stengel-Eskin, M. Socolof, and M. Sonderegger. 2017. Polyglot and speech corpus tools: a system for representing, integrating, and querying speech corpora. In *Interspeech 2017*, 3887–3891. URL https://www.isca-speech.org/archive/Interspeech_2017/pdfs/1390.PDF.
- Pitt, Mark A., Laura Dilley, Keith Johnson, Scott Kiesling, William Raymond, Elizabeth Hume, and Eric Fosler-Lussier. 2007. Buckeye Corpus of conversational speech (2nd release) [www.buckeyecorpus.osu.edu]. Columbus, OH.
- Rosenfelder, Ingrid, Joe Fruehwald, Keelan Evanini, and Jiahong Yuan. 2011. FAVE (Forced Alignment and Vowel Extraction) Program Suite. URL <http://fave.ling.upenn.edu>.
- Stuart-Smith, Jane. 2014. Fine phonetic variation and sound change: A real-time study of Glaswegian. Final Report: RPG-142 (Sounds of the City).

